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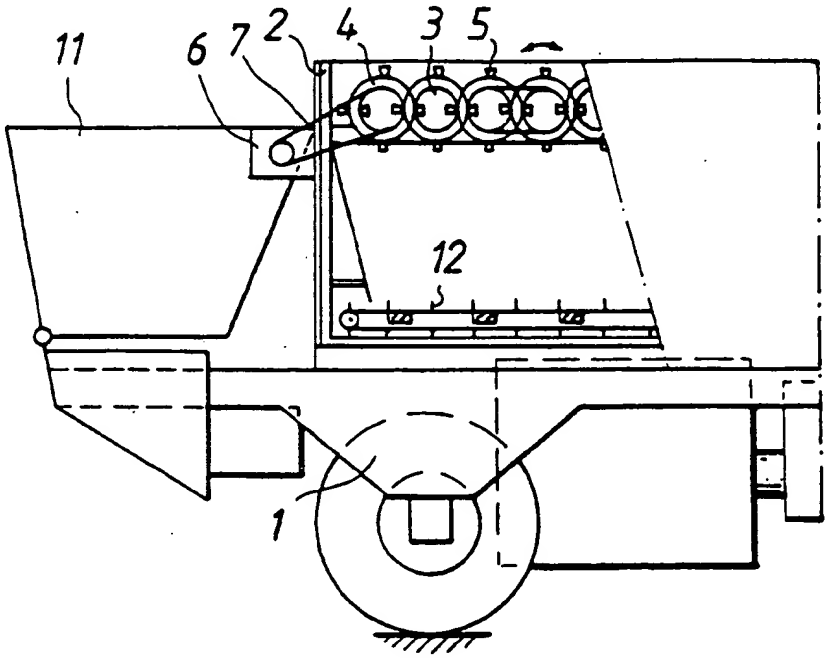

(57) Abstract

This publication discloses a disk screen and method of its operation, said screen and method being suited for the screening of all types of soil including sticky clay soil. The screen is comprised of a plurality of parallel rotatable shafts (3) having intermeshing screen disks (4) adapted on them. The outer perimeter of the disks (4) is provided with ripping teeth (5) suited to rip off material from the raw feed. The shafts (3) of the disk screen are rotated cyclically in opposite directions of rotation, whereby the soil mass to be screened stays on the screen deck and will be ripped from its underside by virtue of the repetitive reversals of direction of rotation into screenable soil.

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Gradation method and device for soil material

The invention is related to a gradation method according to the preamble of claim 1 for screening soil material with a disk screen.

The invention also concerns a disk screen assembly for implementing the method.

The need for topsoil in landscaping is high in residential areas and will increase with the higher volume of construction and concomitant landscape design. Landscaping of yards and parks requires high-quality vegetable mould screened free from disturbing irregularities such as rocks and similar aggregates. Furthermore, topsoil intended for landscaping must be suitable for planting and therefore must be prepared by blending from different types of soil materials. Good soil for sowing and planting is specified as nutrient-containing, porous, containing minerals such as sand and clay as well as organic matter which together with the nutrients is capable of sustaining varied microbiological flora in the soil. The topsoil layer must be free from large objects such as rocks, root bundles, stumps and pieces of wood. Such a soil must further have all ingredients homogeneously blended.

As a by-product of various heavy construction operations, substantial amounts of cut/strip soil is obtained which cannot be reused due to the rocks or wood contained therein. In fact, such soil is often produced close to a potential point of use, whereby it would be advantageous to be able to reuse such cut/strip soil at a reasonable cost thus achieving significant savings in soil purchasing and hauling costs. However, the cut/strip soil must be screened prior to reuse, and due to the lack of effective screening equipment available commercially, cut/strip soil must conventionally be transported to, e.g., dumps to be disposed of as landfill, and methods of its reuse have been lacking. This is undesirable as cut/strip soil contains valuable aggregates provided that its different ingredients could be segregated at the site of origination of the cut/strip soil. Hence, e.g., the rocks

could be directly utilized in the load-bearing subgrade of a road, for instance, and the more fine-grained mineral soil could be mixed with vegetable mould thus producing topsoil suitable for landscaping.

Gradation of cut/strip soil resulting from heavy construction has so far been lacking of suitable equipment. Particular problems have arisen from the handling of sticky and wet soil types such as those containing clay, silt, rocks, stumps and woodland topsoils.

Screening is conventionally used for separating unwanted aggregates from raw feed and blending the desired aggregates. Screening devices are typically based on a wire cloth which is either moved or vibrated, or is put to a revolving motion in an inclined drum screen. Such revolving screens are hampered by heavy weight and relatively low capacity as well as high tendency of plugging particularly at raw feed with clay containing materials. Also bar screens are known in the art with stationary or movable bars or arrangements with vibrating bars.

Different types of disk screens are conventionally used for screening of soil. These screens are comprised of a number of intermeshing disks mounted on parallel shafts, and the shafts are rotated in the same direction, whereby small aggregates of raw feed fall down through the slots between the disks, whereas aggregate sizes larger than the slots remain on the screen and are transported to the edge of the screen and dumped thereof to a collection bin. A disadvantage of such a screen is its inferior performance in the screening of sticky, clay-containing raw feed. The disks of the screen are not capable of ripping the clay-containing raw feed and the sticky soil cannot pass through the slots between the disks. Then, the soil clump lifted onto the screen only rides unscreened over the screen and is finally discharged off from atop the disk shafts. Hence, such sticky clay-containing soil is difficult to screen using conventional equipment.

Depending on their amount of fines, such thixotropic materials whose moisture content is 10 - 90 % of the solids may often be problematic to screen. Also materials rich with fiber- or ribbon-like constituents are difficult to screen and homogenize and/or blend with other materials. Such materials include turf, straw, hay, dump waste and clay-containing soil in which the constituents to be screened away include stumps, roots, large rocks and plastic waste mixed with other soil material. Plastic waste and other materials occurring as long ribbons easily plug a number of screen types, particularly disk screens in which the disk-shaped screen elements are rotatingly mounted on parallel shafts, whereby the material ribbons become wound about the shafts.

Attempts have been made in some screen arrangements to subject the material to be screened to ripping and crushing or other treatment prior to screening in order to assure successful screening and prevent the plugging of the screen.

It is an object of the present invention to achieve a method and device suited for screening of all types of soil including clay soil.

The invention is based on operating the shafts of the disk screen in a cyclically reversible manner, whereby the soil to be screened stays on the screen and is ripped by virtue of reversal of the direction of rotation of the shafts into a material mass from whose underside the ripped aggregates can pass through the screen.

More specifically, the method according to the invention is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the screen assembly according to the invention is characterized by what is stated in the characterizing part of claim 4.

The invention offers significant benefits.

The most significant benefit of the invention is its good capability of segregating and screening sticky raw feed. Accordingly, the screen assembly according to the invention is capable of effectively handling wet clay, manure with a high content of straw and other difficult-to-screen materials. The screening capacity of the screen assembly with these problematic materials is higher than that of other screen types known in the art. Whereas a conventional revolving screen used for screening difficult materials may achieve a screening capacity of approx. 0.5 m^3/min per screen square meter, the screen assembly according to the present invention may reach a capacity of approx. 1.5 m^3/min per screen square meter for the same material. The size of the screen openings is readily alterable. To this end, the shafts of the screen can be mounted by means of conical bushings, whereby the shafts are easy to dismantle and replace by another set of shafts equipped with a different set of screen disks. According to a preferred embodiment of the invention, the screen disks themselves are provided with projections which during the rotation of the disks pierce the material to be screened in a ripping manner, whereby the material is transformed into a form suited to pass through the screen. The drive machinery and power transmission chain of the screen assembly can be provided with a torque converter, thus protecting the screen device against damage to the shafts and screen disks due to wedging of the material. By virtue of the cyclic reversals of the direction of rotation of the shafts, any wedging formed is also automatically dislodged when the direction of rotation of the shafts is reversed.

In the following, the invention will be examined in more detail by means of the attached drawings, in which:

Figure 1 is a sectional side view of an embodiment of the invention mounted on a transport carrier; and

Figure 2 is a top view of the embodiment illustrated in Fig. 1.

The diagrams show only one end of the screen. The dimensions of the screen deck may be varied by using, e.g., a greater number of shafts, whereby the screen deck formed thereof will be correspondingly longer. The construction principle of using parallel shafts will also be evident from the cross-sectional diagrams.

Fig. 1 shows the screen assembly according to the invention mounted on a transport carrier 1. Such a transport carrier is not actually related to the invention, whereby its detailed description is omitted herein. The screen assembly proper comprises a box-shaped framework 2 having the screen shaft set mounted on its upper level. The shaft set is comprised of shafts 3 having screen disks 4 mounted thereon spaced at a distance from each other along the longitudinal axis of each shaft. The disks 4 of each adjacent pair of shafts 3 are shifted sideways in a manner that makes the disks 4 mesh and thus form the openings of the screen deck. The perimeter of each screen disk 4 is provided with four ripping teeth 5 interspaced from each other at 90° angles. In this embodiment the teeth widen toward the outer perimeter of the disk so as to form a claw-like projection at both edges of the tooth. The assembly is driven by means of hydraulic machinery 6 mounted to the end of the framework 2, said machinery being adapted to drive the shafts 3 via a chain transmission 7. In this embodiment also the shafts 3 are connected via two parallel roller chains 8 and chain sprockets 9 into a power transmission chain, whereby the hydraulic motor 6 can drive all shafts 3 synchronously. By virtue of the hydraulic drive machinery, different types of valve arrangements can be advantageously used to implement the reversal of direction of rotation, torque limiting and other details related to screen functions and control.

The end edges of the framework box 2 are provided with fixed baffles 10 which together with the disks of the last shaft closest to the end baffle form an intermeshed screen in the same manner as the shafts 3 with each other. The framework end to which the hydraulic motor 6 is mounted is further provided

with a collection bin 11 for rocks and other separated aggregates. To the bottom of the framework box 2 is adapted a conveyor 12 for the removal of the screened material.

The operation of the screen is as follows: The raw feed to be screened is lifted by means of loader onto the shaft set of the screen. Powered by the hydraulic motor, the shafts of the screen are brought to rotate first in one direction, and subsequently the direction of rotation of the shafts is reversed and the shafts are rotated backward as many turns as they were rotated forward during the first cycle. When the second rotating cycle is completed, the direction of rotation is reversed again and such rotating/reversing cycles are repeated until all desired material being screened has passed through the screen and only the segregated aggregates remain on the shafts. Then, the screen shafts are controlled to rotate toward the collection bin, whereby the aggregates remaining on the shafts will be discharged into the collection bin.

The parameters of each rotating cycle may be selected relatively freely, and in fact, are advantageously adapted variable by means of, e.g., a programmable logic controller, whereby the operation of the screen device may be adjusted according to the material being handled. However, the duration of a rotating cycle may not be adjusted unidirectionally so long as to remove the material being screened away from screen deck. Actually, maximum efficiency in conjunction with several types of materials is attained if the disk tooth travel during a single cycle is very short, whereby the maximum number of ripping actions working on the underside of the material is achieved per time unit. Also a high tooth tip speed is desirable, whereas the inertial of the material mass being screened then tends to keep the material stationary while the disks impose the ripping action from underneath the material. If the angle of rotation of the shafts during each rotating cycle is kept smaller than a full revolution at, e.g., a quarter or half revolution, the benefit is gained that ribbon-like materials cannot become wound about the shafts and thus plug the screen. Then, however, even wear of the

screen disks necessitates occasional rotation of the shafts unidirectionally at least so long as to change the disk surface and ripping tooth facing the underside of the material layer resting on the disks.

Besides the embodiment described above, the present invention may have alternative embodiments. The ripping edge of the disk may advantageously be formed by either an arc segment of a circle having a larger radius than that of the disk on the average and further so that the discontinuity of the disk radius is radially perpendicular at an angle of 90° to the tangent of the disk, or alternatively, advantageously aligned at an acute angle.

Also other ripping forms of the disks and teeth are possible provided that the shape of the disk does not become, e.g., star-like in such a manner that readily permits the aggregate being screened to wedge between the shaft and the spokes of the star-shaped disk. It is also important that the ripping projections of the ripping disks of screen do not radially deviate excessively from the average radius of the disk or the radius of the other parts of the disk. Advantageously, the radial height of the ripping part of the rotating disk should not exceed the radius of the disk by more than 1/4 of the disk radius. Otherwise, the rotating disks may permit the aggregates of the material being screened to reach a situation in which the material being screened wedges between the disk and the shaft. Obviously, the disks need not be circular, but instead, also triangular, square and other shapes of the disk are feasible.

The screen assembly framework, the shafts and their mounting fixtures and drive means may advantageously be mounted on springed chassis to prevent bending damages on the shafts. The power transmission of screen shafts can be arranged in several different ways, one of the preferred methods being the adaptation of a hydraulic motor and a torque converter on each shaft. Electric or combustion motors are also possible alternatives to the hydraulic drive machinery, while then

the implementation of a rapid reversal of the direction of rotation of the shaft will be more difficult than with hydraulics.

Claims:

1. A method for screening soil or similar material by means of a disk screen comprising a number of parallel shafts on which are adapted intermeshing screen disks, in which method

- the material to be screened is lifted onto a screen deck formed by the shaft set (3) of the screen, and

- the shafts are rotated whereby the material to be screened can pass through the screen deck via the slots between the shafts (3) and the screen disks (4), whilst such material aggregates that are oversized to pass through said slots remain on the screen deck,

characterized in that

- the shafts (3) are rotated in a cyclically reversible manner whose angle of rotation during a cycle of one direction is so limited as not to permit the material resting on the screen deck from being transferred away from atop the screen deck formed by the shafts (3) of the screen assembly.

2. A method as defined in claim 1, characterized in that the angle of rotation during a cycle of one direction is smaller than a full revolution of the shafts (3).

3. A method as defined in claim 1 or 2, characterized in that the reversal of the direction of rotation of the shafts is performed without essential pausing of the rotational motion of the shafts.

4. An assembly for screening soil or similar material, said assembly comprising

- a framework (2),

- a plurality of parallel and aligned shafts (3) adapted supported by said framework (2) and spaced at a distance from each other, said shafts forming a screen deck,

- a plurality of screen disks (4) adapted on each shaft (3) and having such a diameter and position on the shafts (3) that the disks (4) on adjacent shafts (3) partially intermesh, and

- at least one actuator means (6) for rotating said shafts (3),

characterized by

- means for controlling said actuator means (6) cyclically so as to perpetually reverse the direction of rotation of said shafts (3) after a predetermined duration of each rotating cycle.

5. An assembly as defined in claim 4, characterized in that ripping teeth (5) are adapted to the perimeter of the screening disks (4) in a projecting manner from the perimeter of said disk (4).

6. An assembly as defined in claim 4 or 5, characterized in that said actuator means is a hydraulic motor (6) connected via a torque limiter.

7. An assembly as defined in claim 4 or 5, characterized in that said actuator means is comprised of separate hydraulic motors adapted on each shaft (3) and connected to their respective shaft (3) via a torque converter.

8. An assembly as defined in any of foregoing claims 4 - 7, c h a r a c t e r - i z e d by a programmable logic controller or similar data processing means adapted to the control of the assembly functions.

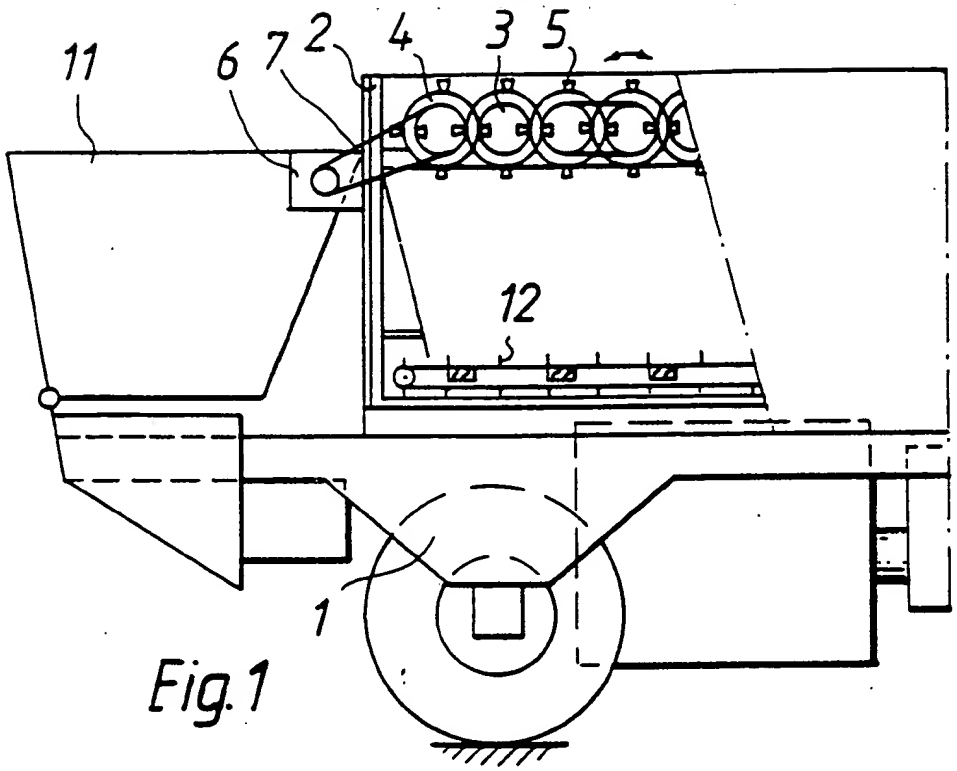

Fig. 1

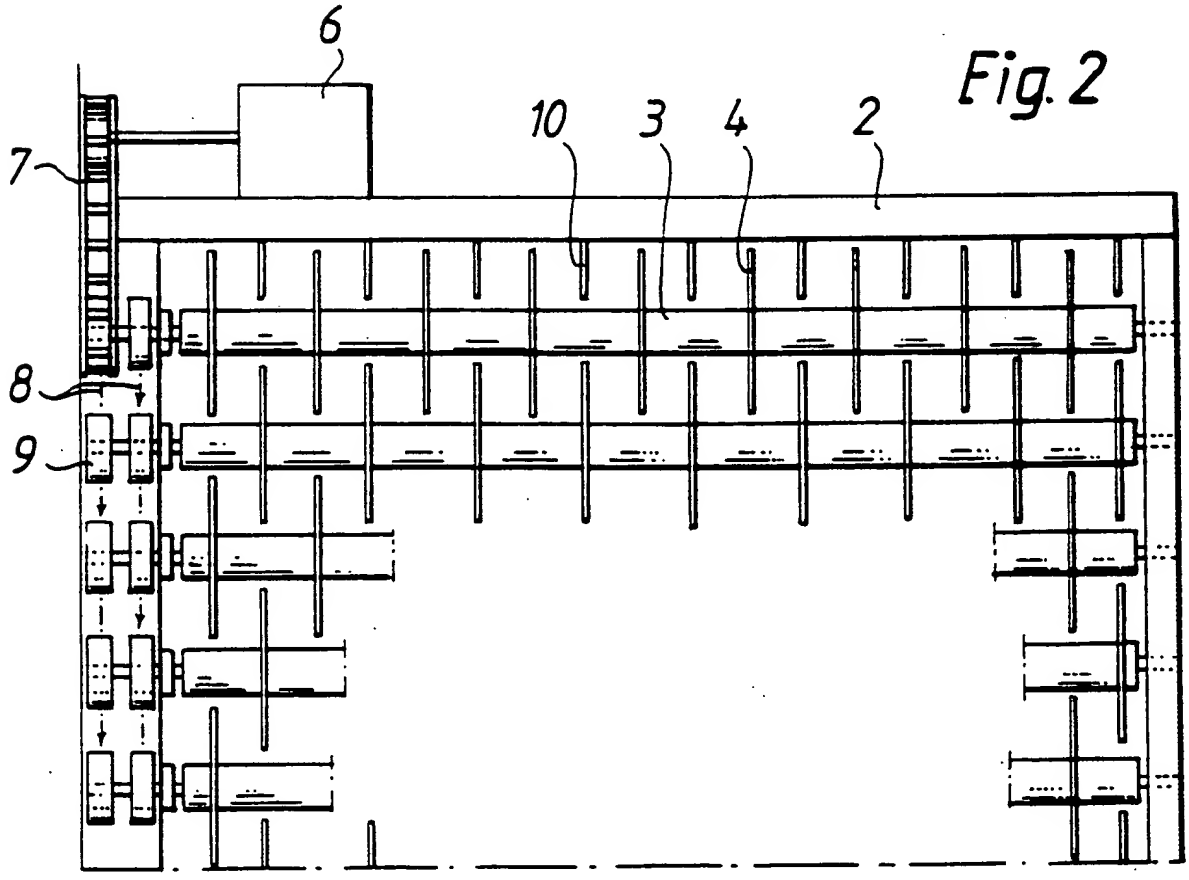

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
FI 94/00446

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B07B 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	SE, B, 442174 (OSCAR WILJE), 9 December 1985 (09.12.85), figure 1, abstract --	1,3-8
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Y	FI, B, 70379 (RADER COMPANIES, INC.), 27 March 1986 (27.03.86), figures 1,3, claims 1,5 --	1,3-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, A1, 3818946 (PASSAVANT-WERKE AG), 14 December 1989 (14.12.89), claims 1,3	1,2
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INTERNATIONAL SEARCH REPORT

Information on [redacted]nt family members

31/12/94

International application No.

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